TIP 279: Implementation of a Full-Topology, Robust, and Generalized State Estimator

Context

The need for more frequent system analysis is growing due to an increasing penetration of distributed energy resources (such as wind generation) that results in greater variability in all the quantities associated with the state of the transmission system. To meet these demands, a flexible state estimation tool is of paramount importance. State estimation is an essential tool for real-time power system monitoring and is a requirement for all real-time security analysis and advanced control tools. Access to a refined and accurate description of the current state of controlled devices and subsystems in the transmission grid is essential for real-time wide-area control and the development of software tools that help improve system performance and online real-time operation of the transmission grid.

Description

This project can revolutionize state estimation algorithms used within a control center. The major challenge will be to write state estimation algorithms that uses the full-topology (node/breaker) power system models contained within the control center energy management systems (EMS). Present state estimators are cumbersome and do not function efficiently in today's massive data environment.

This project will further develop and test a state estimator tool in the PowerWorld software system. This tool will take advantage of modern programming techniques and advanced state estimator theory to exceed the performance of the current BPA state estimator by being more robust and using a generalized full system topology for its analysis. One important implication is that the status of switching devices (such as breakers and disconnects) will be known for analysis input, not assumed. Completion of the following tasks will enable successful implementation:

1. Write an Orthogonal Factorization built on QR factorizations using Givens Rotations: Fully implement sparse-matrix QR factorizations.

2. Expand State Estimation Algorithms to utilize Full-Topology Models: Fully integrate use of the full-topology power system model (including real-time switching status) into the state estimation framework.

3. Implementation of Topology Error Detection in the Full-Topology Framework: Full implementation of this technology on a full-topology model.

Why It Matters

State Estimation is now a fundamental tool used to safely operate a transmission system. On-line system security analysis tools such as contingency analysis, voltage stability analysis, and transient stability analysis all require an initial power system state as a starting point for their analysis. Improvements in ensuring the reliable operation of the state estimation tool can be immediately applied. The BPA goal to maximize use of the transmission system requires that the BPA engineering staff has a complete understanding of what the maximum capability actually is. Examples:

•Reduced Likelihood of Blackout: The U.S.-Canada Power System Outage Task Force report on the August 14, 2003 blackout identified "inadequate System Knowledge" as one of the four basic causes of the blackout. Increased real-time situational awareness will lead to a wider range of investigations. Preventing just one regional blackout in 50 years could save BPA between $1 million to $10 million/year.

•Seamless exchange of cases between real-time and planning facilitates comparing actual operating outcomes with planned operations as well as correcting model discrepancies.

•Simplified maintenance and operation allowing data managers and engineers to deal with a single format. No need to understand diverse multiple models.

• Enhanced operating practices, greatly increasing system predictability.

Goals and Objectives

The goal of this project is to create a state estimator that overcomes previous limitations by meeting two major objectives:

1. It must include integrated topology error detection
2. It must operate on a single power system model representing full topology

This project will show that switching to a single full-topology representation of the power system and the capability to dynamically handle arbitrary switching topologies will be the key enabling technology that allows the objectives to be met in a real commercial product.

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Project Start Date: October 1, 2012

Project End Date: September 30, 2013

Reports & References (Optional)

Links (Optional)

Participating Organizations

PowerWorld Corporation

Funding

Total Project Cost:	$288,730
BPA Share:	$144,360
External Share:	$144,370
BPA FY2013 Budget:	$144,360

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